Mark scheme

Section A

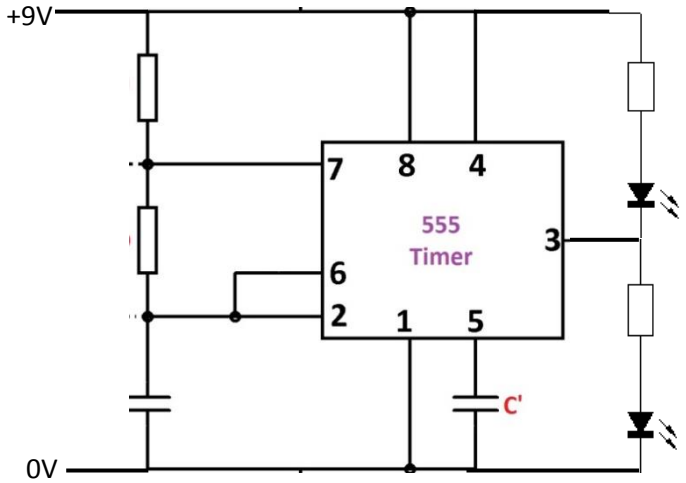
Question	Part	Sub part	Marking guidance	Marks
1	**a**		Design requirements – *up to 4 marks* 1 mark for each requirement. 2 case and 2 circuit requirements asked for. Case: reference to a material, colour, dimension, safety, hygiene, weight, number of shapes, theme or similar. *1 mark each* *e.g. the case needs to be lightweight..* Circuit: reference to output component, input, battery access, circuit board, function of circuit, small or compact circuit (not just 'small') or similar. *1 mark each* *e.g. the circuit output needs to have bright LEDs.* Do not credit repetition of the requirements given in the brief	Total (4 marks)
	b		Mark both designs holistically, giving credit for best features. 7-8 marks – 2 creative designs that meet all the stated criteria and the ideas are well-communicated. 5-6 marks – 2 ideas with less evidence of creativity, but still meeting the criteria, and good communication. 3-4 marks – 1 idea that is clearly communicated, or 2 ideas with little creativity and detail. 0-2 marks – a very basic attempt with poor clarity of communication. Evidence of creativity could include, for example, bright colours, loud sound output, light output pattern, interesting sequence of LEDs, shape of the case.	Total (8 marks)
	c		Case development - *up to 10 marks.* Case construction details – *up to 2 marks* *1 for each ref. to a method e.g. vacuum forming, injection moulding, gluing, joints, dimensions, battery access* materials – *up to 2 marks* *1 mark to ref. to a generic material e.g wood, metal, plastic.* *2 marks for a specific material e.g. HIPS, polystyrene, acrylic, ABS, or similar suitable material.* Switch/sensor details – *up to 3 marks* 1 mark for naming input component. 1 mark for indication of how it is triggered. 1 mark for suggesting how input component is fitted. Quality of communication of case development – *up to 3 marks* 0 marks for unclear development of how the case is made.	Total (10 marks)

			1 mark for basic sketch with little or no relevant annotation of how the case is made. 2 marks for a clear sketch and some detailed annotation of case construction. 3 marks for a coherent sketch, clearly communicated with good detail in annotations. A full and comprehensive design showing development from the ideas stage.	
	d	**i**	Reference to the use of a microcontroller, programmed to create a more complex and interesting output -*up to 2 marks* 1 mark for reference to programming. 1 mark for creating a more complex output. e.g. Several LEDs flashing in a sequence Sounder playing a tune Sounder playing 'sound effects' Vibrations	Total (2 marks)
	d	**ii**	1 mark for naming "Process". *1 mark* for each specific component named Input components could include PTM switch, reed switch, LDR, or other suitable response. Output components could include LED, bulb or lamp, buzzer, piezo transducer, sounder, bell, or similar.	Total (5 marks)
	e		*Up to 4 marks* for circuit diagram and notes. *1 mark* for a basic sketch showing some symbols for microcontroller *or* output components. No notes worthy of credit. *2 marks* for a circuit diagram showing a microcontroller and output component(s), where parts of the circuit are correctly connected. *3 marks* for a coherent circuit diagram with correct connections for outputs. *4 marks* for circuit with both sound and light outputs connected to the outputs of a microcontroller.	Total (4 marks)
	f		Explanation of features such as: • Battery access • Easy to clean • Removable parts for easy repair Award *2 marks* for each justified point made. Award *1 mark* for a simple, unjustified point.	Total (2 marks)

Section B

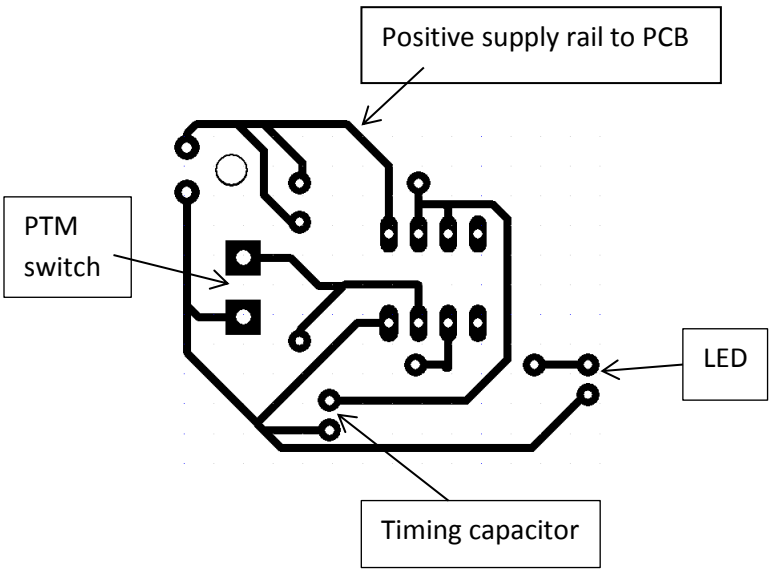
2	**a**	**i**	Any relevant, suitable product named	Total (1 marks)
		ii	*Up to 3 marks* *1 mark each* for reference to • Can be reprogrammed • Can be used in place of multiple ICs • Can result in smaller PCB • Can be programmed to perform different functions in different products Or similar suitable response.	Total (3 marks)
	b	**i**	1 mark for an answer in the range 3 to 5 volts.	Total (1 mark)
		ii	1 mark for an answer naming a voltage regulator	Total (1 mark)
	c		*Up to seven marks* 1 for recognition of an input (decision box, if-then) 1 for outputs on 1 for wait 0.25 seconds 1 for outputs off 1 for wait 0.25 seconds (For a frequency of 2 Hertz 1 for repeating the sequence twice more 1 for loop back to start Basic or other program systems acceptable (simple re-writes of the question, giving no evidence of a programming system – no marks)	Total (7 marks)

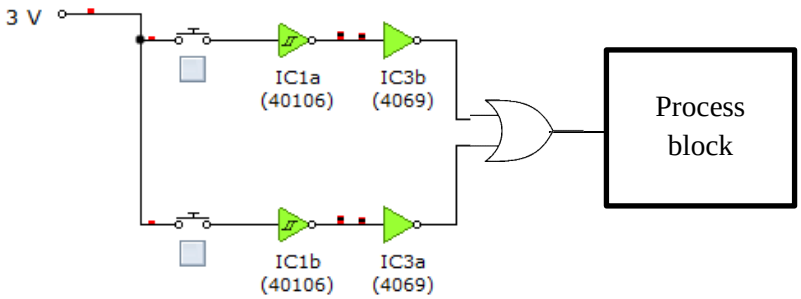
3	**a**	**i** **ii** **iii**	1 mark for each suitable description Astable – a system with no stable states; can be used to generate a pulse Monostable - a system with one stable state which, when triggered can be used to produce a time delay Bistable – a system with two stable states that needs a trigger to switch between each state	Total (3 marks)
	b		*1 mark for each correct answer* IC: Integrated circuit DIL: Dual in line	Total (2 marks)

	c	**i**	*Award marks as follows, up to a maximum of 6 marks* 1 mark for correct LED symbols 1 mark for correct LED orientation 1 mark for LED protective resistors 1 mark for connections that will cause the LEDs to flash alternately (one sinking and one sourcing pin 3 of the 555) 1 mark for positive supply rail 1 mark for 0 volt rail  	Total (6 marks)
	c	**ii**	*1 mark for correct answer* Pulse	Total (1 mark)
	d		*1 mark for each of the following correct points* 1 mark for drawing a pulse 1 mark for indicating a period of 1 second 1 mark for drawing having equal mark-space ratio 1 mark for indicating mark and space	Total (4 marks)

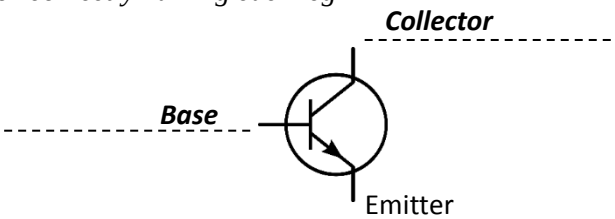
4	**a**		*1 mark for each correct answer* Answers relating to: CAD Advantages: Quick and easy to modify Files can be saved, stored and retrieved Files can be emailed Wide range of components available Can see if circuit works without buying components Disadvantages: Expensive to set up Software may not have all components Takes time to learn software Hardware/software faults can cause work to be lost Breadboard Advantages: Uses real components Gives indication of size of circuit	Total (4 marks)

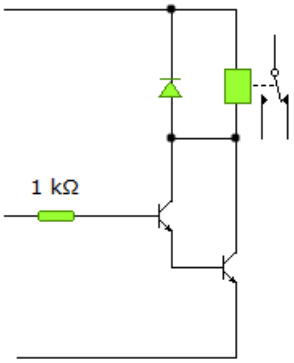
			Components easily replaced Disadvantages: Many components may need purchasing Damage to components not always evident Can be relatively slow to build a circuit Can be difficult to fault find on a large, complex circuit *Accept any suitable answers*	
	b		*Photo-etch method* *1 mark awarded for each correct stage.* 1. Design the PCB and produce a mask (CAD or hand drawn) 2. Expose photo etch board to ultra violet light 3. Develop the image 4. Etch the board in a bubble-etch tank 5. Wash the etched board 6. Clean and drill ready to be populated *CNC method* *1 mark awarded for any stages from:* 1. Design the using CAD 2. Convert to PCB / autoroute 3. Create CNC CAM file 4. Clamp copper clad board in position 5. Set Z position 6. Route using CNC router 7. Drill holes using CNC drill	Total (6 marks)
	c	**i**	*2 marks available for each QC check* *1 mark for simple answer* *2 marks for explanation* Suggested answers: Continuity of tracks: visual check or using a multimeter Size of holes so that pins/wires will fit No tracks/pads missing Tracks and pads have been cleaned to help create solder joints / prevent dry joints	Total (4 marks)

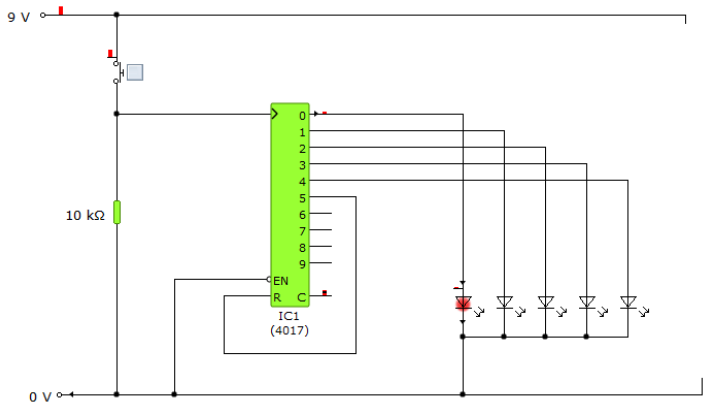
	c	**ii**	*Award 1 mark for each correct addition* *Position on PCB can vary but must be correct relative to other components and circuit diagram*  	Total (4 marks)

5	**a**	**i**	*1 mark for correctly naming the type of gate* AND gate	Total (1 marks)
	a	**ii**	*1 mark for each correct output; 1 mark for the correct input combination* **Input B** / **Input A** / **Output** 0 / 0 / ***0*** 0 / 1 / ***0*** ***1*** / ***0*** / 0 1 / 1 / ***1***	Total (4 marks)
	b	**i**	OR gate drawn in correct position  	Total (1 marks)
	b	**ii**	*1 mark for correctly named* OR gate	Total (1 marks)

6	**a**		*1 mark for each point made, up to 3 marks* Suggested answers: Identical products Very accurate / high tolerance Very little waste Waste material can be recycled Manufacture can be automated, allowing for continuous production Possible to make in a range of colours Accept any suitable answer	Total (3marks)
	b		*1 mark for each point made, up to 3 marks* Relatively inexpensive so can be done in schools Easy to shape formers using hand tools Can be made using different colours Former can be reused Easy to cut and finish materials Equipment can be operated by student Accept any suitable answer	Total (3 marks)
	c		*1 mark for appropriate features, up to 3 marks* Features to include: Draft angle on sides Flat base Rounded corners Vent holes (counterbored) Smooth surface	Total (3 marks)

7	**a**	**i**	*1 mark for correctly naming the arrangement* Darlington pair	Total (1 marks)
	a	**ii**	*1 mark for correctly naming each leg*  	Total (2 marks)
	b		*1 mark for formula* $V_{out} = \frac{R_2}{R_1 + R_2} \times V_s$ *1 mark for substitution* $V_{out} = \frac{3700}{6300 + 3700} \times 12$ *1 mark for correct answer* 4.44 volts	Total (3 marks)

	c	**i**	1 mark for diode connected between Darlington collector connection and positive supply rail 1 mark for correct orientation  	Total (2 marks)
	c	**ii**	1 mark for correctly naming diode	Total (1 marks)

8	**a**		1 mark for a resistor connected between the switch and 0V rail 1 mark for connecting switch to +V rail and connecting switch to clock input of IC 1 mark for connecting IC output pin 5 to reset pin  	Total (3 marks)
	b		*1 mark for simple answer* *2 marks for explanation* When a mechanical switch is pressed the switch contacts may bounce against each other, turning the switch on and off rapidly, creating several unwanted input pulses.	Total (2 marks)

9			QWC question Looking for examples of the impact of sustainability and sustainable design that apply during the life cycle of a product. Discussion could include: Renewable materials Use of renewable energy in manufacture, processing, distribution, etc. Maintenance Recycling Planned obsolescence Disposal Pollution Environmental impact	Total (8 marks)

			Social and cultural issues Consider the technical content and quality of communication. Marks awarded as follows: 0 marks – no answer worthy of credit. 1-2 marks Limited coverage. Just one point discussed. Many spelling and punctuation mistakes. Limited use of technical vocabulary. 3-4 marks Discussion of advantages and disadvantages of two products. Some spelling, punctuation or grammar errors. Poor structure of answer, and repetition made. 5-6 marks Good coverage and a well-structured response. Advantages and disadvantages for at least two products discussed using specific terms and vocabulary. There may be one or two spelling or punctuation mistakes, or minor grammar error. 7-8 marks Excellent coverage and depth of answer, and a well-structured response. Several products discussed using technical terms in good detail. Excellent spelling, grammar and punctuation. Avoidance of repetition.	